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Néel-type Skyrmion Lattice in a Polar Magnetic Semiconductor

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Following the early prediction of the skyrmion lattice (SkL)—a periodic array of spin vortices—by Bogdanov and coworkers [1], it has been observed recently in various magnetic crystals mostly with chiral structure [2]. Although non-chiral but polar crystals with Cnv symmetry were identified as ideal SkL hosts in pioneering theoretical studies, this archetype of SkL has remained experimentally unexplored. Here, we report the discovery of a SkL in the polar magnetic semiconductor GaV4S8 with rhombohedral (C3v) symmetry and easy axis anisotropy [3]. The SkL exists over an unusually broad temperature range compared with other bulk crystals and the orientation of the vortices is not controlled by the external magnetic field but instead confined to the magnetic easy axis. Supporting theory attributes these unique features to a new Néel-type of SkL describable as a superposition of spin cycloids in contrast to the Bloch-type SkL in chiral magnets described in terms of spin helices.
We found that the strong orientational confinement of the vortices ensures the robustness of two distinct skyrmionic states with a core magnetization pointing either up or down the easy axis. This may facilitate a unique magnetic control of the SkL by magnetic fields applied perpendicular to the vortex cores in contrast to cubic helimagnets where vortex cores instantaneously co-align with the magnetic field. In addition, the polar crystal structure of GaV4S8 may be exploited for a non-dissipative electric field control of the SkL.

[1] A. N. Bogdanov and A. Hubert, J. Magn. Magn. Mater. 138, 255 (1994).
[2] S. Mühlbaueret al., Science 323, 915 (2009).
[3] I. Kézsmárki et al., http://arxiv.org/abs/1502.08049

Primary author: Prof. KÉZSMÁRKI, István (Department of Physics, Budapest University of Technology and Economics)

Co-authors: Prof. LOIDL, Alois (Experimental Physics V, University of Augsburg); Dr WHITE, Jonathan (Laboratory for Neutron Scattering and Imaging, Paul Scherrer Institut); Prof. MOCHIZUKI, Masahito (Department of Physics and Mathematics, Aoyama Gakuin University); Dr MILDE, Peter (Institut füur Angewandte Photophysik, TU Dresden); Dr BORDÁCS, Sándor (Department of Physics, Budapest University of Tchnology and Economics); Dr TSURKAN, Vladimir (Experimental Physics V, University of Augsburg)

Presenter: Prof. KÉZSMÁRKI, István (Department of Physics, Budapest University of Technology and Economics)

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